

Guidelines for Conducting Required Monitoring for Timber Harvest Related Discharges Enrolled Under the Waiver of Waste Discharge Requirements



**Central Valley Regional Water Quality Control Board
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1.0. Introduction – A Rationale for Monitoring

“If you aren’t monitoring, you aren’t managing.”

– Sherman Swanson (University of Nevada-Reno, 1992)-

This document contains guidelines on how to comply with the Monitoring and Reporting Conditions that are applicable to the various timber harvest activity categories specified in Attachment A “Waiver of Waste Discharge Requirements for Discharges Related to Timber Harvest Activities” (Waiver) for the Central Valley of California adopted by the Regional Board in 2005 (http://www.waterboards.ca.gov/centralvalley/adopted_orders/Waivers/R5-2005-0052.pdf). Impairment of beneficial uses through increased erosion and sedimentation is the focal point of these Monitoring Guidelines, as the cause-and-effect relationships between timber harvest and erosion/sedimentation are well documented¹.

These guidelines will attempt to clarify the specific monitoring requirements of the Regional Board’s Monitoring and Reporting Conditions and Monitoring and Reporting Program No. R5-2005-052. This document will outline clear objectives for monitoring, will explain monitoring requirements for each Waiver Category, and will provide directions on how to complete each required monitoring step.

It should be noted that compliance with the Monitoring and Reporting Conditions and Monitoring and Reporting Program No. R5-2005-0052 requires a time commitment on the part of the landowner to learn the basic principles of monitoring and to conduct monitoring activities on their own timber harvest plan (THP) area. Landowners unwilling to make this commitment should strongly consider paying a Registered Professional Forester (RPF) or other qualified professional to do it.

1.1. Objectives for Monitoring

Without clear objectives, monitoring can be a waste of time and resources for the landowner, and the information produced from such monitoring activities would provide little information to the Regional Board. The objectives for the Monitoring and Reporting Program are:

1. Determine if best management practices (BMPs), mitigations, and management measures have been properly put into place before the start of the winter period (November 15th through April 1st) (i.e., agency and implementation monitoring).
2. Determine if significant pollution occurs as a result timber harvest activities during the winter period (i.e., forensic monitoring).
3. Determine if the management measures were effective in preventing significant pollution during the winter period (i.e., effectiveness monitoring).

¹ (Megahan and Kidd, 1972; Swanson and Dyrness, 1975; Reid and Dunne, 1984; Madej and Ozaki, 1996; Rice, 1999; Lewis et al., 2001; Wemple et al., 2001)

One of the most important assumptions of the Waiver is that no significant threats to water quality will occur if the Forest Practice Rules, United States Forest Service (USFS) best management practices (BMPs), Waiver criteria and conditions, and Regional Board staff recommendations are properly implemented. The rationale for the Monitoring and Reporting Conditions is to test these assumptions by providing Regional Board staff with feedback regarding the adequacy and effectiveness of the Waiver. Results from monitoring reports will be used to refine the design and implementation of water quality protection measures (i.e., BMPs) – a process referred to as adaptive management.

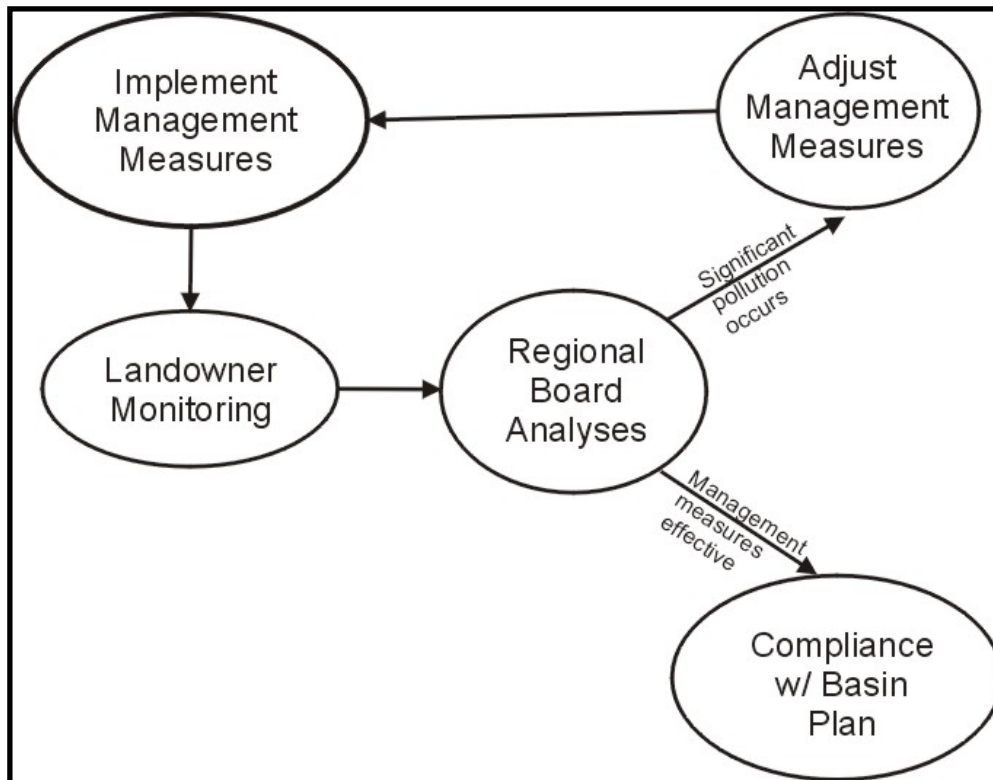


Figure 1. Schematic illustrating the feedback loop between monitoring, management, and achieving water quality objectives.

The adaptive management process is beneficial to the landowner and to the Regional Board because it allows for the adjustment of management measures based on what works on the ground and what doesn't. The adaptive management framework allows the landowner to test creative and economical engineering solutions to prevent water quality degradation. It also allows Regional Board staff to determine if their recommendations are too stringent, not stringent enough, or adequate for meeting water quality objectives.

2.0. What Am I Supposed to Monitor? – Determining Threat to Water Quality

Landowners are not expected to monitor every square inch of their THPs. Rather, landowners are asked to focus their attention on sites where timber harvest activities have the greatest risk to water quality. Determining the threat to water quality will depend upon the following, or a combination of the following, conditions:

1. Beneficial uses of water and water quality objectives;
2. Current water quality conditions;
3. The physical setting of the THP area;
4. Intensity of activity and proximity of activity to watercourses.

2.1. Beneficial Uses of Water and Water Quality Objectives

The beneficial uses of water must be taken into account when determining if a management activity has the potential to threaten water quality. The beneficial uses of water potentially affected by timber harvest activities include: municipal and domestic water supply (MUN); cold freshwater habitat (COLD); warm freshwater habitat (WARM); wildlife habitat (WILD); aquatic habitat for spawning, reproduction, and/or early development (SPWN); and hydropower generation (POW). The beneficial uses of water for specific surface water bodies are listed in table II-1 of the Water Quality Control Plan for the Central Valley Region (Basin Plan)

(http://www.waterboards.ca.gov/centralvalley/available_documents/basin_plans/SacSJR.pdf).

The protection and enhancement of beneficial uses require that certain water quality objectives must be met for surface waters. Water quality objectives are numeric or narrative standards for different water quality parameters (i.e., sediment; turbidity; temperature; etc.) that can be directly linked to a beneficial use. The following water quality objectives have the highest likelihood of being affected by timber harvest activities:

Sediment

Sediment refers to suspended sediment, which is sediment that remains suspended in the water column due to turbulent mixing processes. Although the size of suspended sediment is dependent upon water velocity, sediment in suspension is typically sand-sized or smaller (i.e., less than 1/16 inch in diameter). Sediment in suspension is also referred to as fine sediment. The Basin Plan states that suspended sediment load (i.e., the mass of sediment in suspension) and suspended sediment discharge rate (i.e., the rate of suspended sediment transport) of surface waters shall not be altered in such a manner as to cause nuisance or adversely affect beneficial uses.

Settleable Material

Timber harvest activities can increase the delivery of coarse sediment (greater than 1/16 inch in diameter) to watercourses. Deposition of coarse sediment can cause the elevation of the channel to raise - a process referred to as channel aggradation. Narrative standards for settleable material state that waters shall not contain

substances in concentrations that result in the deposition of material that causes nuisance or adversely affects beneficial uses. Examples of adverse effects from settleable material include the infilling of pool habitat with sediment or the loss of reservoir capacity for hydropower generation.

Temperature

The natural receiving water temperature of intrastate waters shall not be altered unless it can be demonstrated to the satisfaction of the Regional Water Board that such alteration in temperature does not adversely affect beneficial uses. If beneficial uses include cold freshwater habitat (COLD) and warm freshwater habitat (WARM), then at no time or place shall the temperature be increased more than 5°F above natural receiving water temperature. Special numeric temperature objectives exist for the Sacramento River (Table III-4; pg. III-8.00;

http://www.waterboards.ca.gov/centralvalley/available_documents/basin_plans/SacSJR.pdf)

Turbidity

Turbidity is a measure of how cloudy the water is from sediment or other suspended solids. Waters shall be free of changes in turbidity that cause nuisance or adversely affect beneficial uses. Increases in turbidity attributable to controllable water quality factors shall not exceed the following limits:

- Where natural turbidity is between 0 and 5 Nephelometric Turbidity Units (NTUs), increases shall not exceed 1 NTU.
- Where natural turbidity is between 5 and 50 NTUs, increases shall not exceed 20 percent.
- Where natural turbidity is between 50 and 100 NTUs, increases shall not exceed 10 NTUs.
- Where natural turbidity greater than 100 NTUs, increases shall not exceed 10 percent.

2.2. Current Water Quality Conditions

The threat to water quality is dependent on the current water quality conditions of the watershed. The threat to water quality is higher in watersheds that have total maximum daily load (TMDL) or 303(d) listings for sediment or temperature. However, the only listing for sediment, related to timber harvest activities, for the Central Valley Region is Fall River (CalWater ID 52641031). Portions of the Pit River (CalWater ID 52661080), North Fork of the Feather River (CalWater ID 51812000), and Willow Creek (CalWater ID 54021051) have been 303(d) listed for temperature. The threat to water quality from timber harvest activities may also be elevated if there is documented non-compliance with Basin Plan standards by the landowner, or known/suspected watershed impacts.

The presence of federally listed salmon species within a planning watershed may also elevate the risk to water quality posed by timber harvest activities. These watersheds are termed Threatened or Impaired watersheds (T&I), and are subject to special requirements under the California Forest Practice Rules. The following link can help to

determine if a landowner's THP falls within a T&I watershed:

<http://frap.cdf.ca.gov/projects/esu/esulookup.asp>.

2.3. Physical Setting of the THP

The threat to water quality is dependent on the physical setting of the THP area. The combination of geology, climate, topography, and previous disturbance can determine how sensitive an area is to timber harvest activities. The most important points to consider when determining the threat to water quality are:

Geology

Geology is a very important factor that controls runoff characteristics, slope steepness, stream characteristics, and how susceptible a soil is to erosion and landsliding (Montgomery, 1999). In the Central Valley Region, soils derived from decomposed granite (DG) or rhyolite are particularly susceptible to surface erosion.

Climatic Characteristics

Climate is responsible for the amount and intensity of precipitation, and whether precipitation falls as rain or snow. These factors drive runoff patterns and sediment transport processes. The risk to water quality is higher in areas that receive abundant precipitation in the form of rain. Mountainous areas between 3000 and 6500 feet in elevation can be susceptible to rain-on-snow events, which can cause catastrophic erosion events. Areas that receive predominantly snowfall have a lower risk to water quality because peak runoff from snowmelt is usually less than that from high intensity rainstorms or rain-on-snow events.

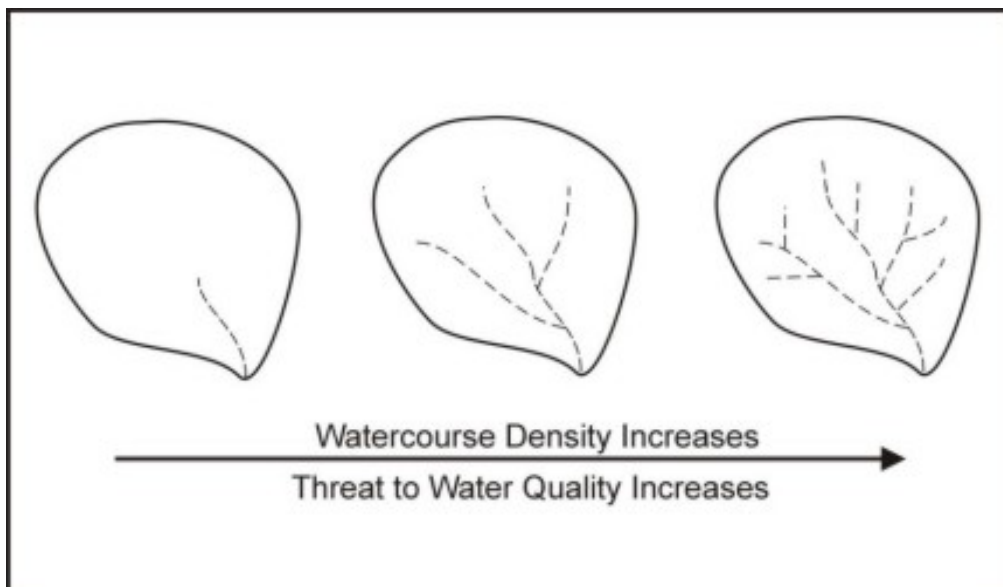


Figure 2. Schematic showing how the threat to water quality increases with increasing watercourse density. The polygons represent watersheds and the dashed lines represent watercourses.

Watercourse Density

Risk to water quality increases when an activity is close to a watercourse. The average distance to a watercourse decreases as the density of watercourses (i.e., mile of watercourse per square mile of land area) increases (Figure 2). An important point to consider is how many watercourses are within the THP area. As the length of watercourses within a project area increases – the threat to water quality increases. To determine how many watercourses are in the THP area, look at the THP map.

Classification of Watercourses

The threat to water quality is highest for Class I watercourses, followed by Class II watercourses, then by Class III watercourses (Table 1). The threat to water quality may also be high for Class IV watercourses if they are domestic water sources. To determine the classification and presence of watercourses within the THP area, check Section II.26.a. of the THP and the THP map.

Water Class	Water Class Characteristic or Key Indicator of Beneficial Use
I	1) Domestic supplies, including springs, on site and/or within 100 feet downstream of the operations area; and/or 2) Fish always or seasonally present onsite, includes habitat to sustain fish migration and spawning.
II	1) Fish always or seasonally present offsite within 1000 feet downstream; and/or 2) Aquatic habitat for nonfish aquatic species; 3) Excludes Class III waters that are tributary to Class I waters
III	1) No aquatic life present, watercourse showing evidence of being capable of sediment transport to Class I or II waters under normal high water flow conditions after completion of timber operations.
IV	1) Man-made watercourses, usually downstream, established domestic, agricultural, hydroelectric supply or other beneficial use.

Table 1. Description of water classification system in the California Forest Practice Rules.

Slope Steepness

How steep are the hillslopes? Persistent surface erosion generally requires slopes steeper than 3-7% (Savat and DePloey, 1982; Luce and Black, 1999). Landslides become much more common when slopes exceed 60-70% (Rice, 1977; Dietrich et al., 2001). Looking at the THP map is the best way to evaluate the steepness of the THP area. Steep slopes are portrayed by closely spaced contour lines. When contour lines are further apart, the slope is gentler. If the EHR is high or extreme (see Section II.17. of the THP), then slopes will typically be steep. Also, if Section 21.b,c,d, or e. of the THP are checked yes, then some portions of the THP are in excess of 50% slope.

Presence of Unstable Areas

Landsliding can deliver large volumes of sediment to watercourses. Operating in and around unstable areas has the potential to impact water quality. Check the THP map to determine if unstable areas are within the THP area.

Erosion potential

Threat to water quality increases as the erosion hazard rating (EHR) progresses from Low to Extreme. Erosion potential is dependent on soil texture, soil depth, precipitation intensity, slope steepness, and the amount of cover provided by vegetation. To determine EHR check Section II.17. of the THP.

2.4. Intensity of Activity and Proximity of Activity to Watercourses

The threat to water quality posed by timber harvest activities is dependent on the potential of the activity to cause disturbance and its proximity to watercourses (Figure 3). Risk to water quality generally increases as the potential for disturbance increases and the distance to the watercourse decreases. The potential for disturbance is highest when the activity can trigger landsliding, results in concentrated runoff, causes soil compaction, or reduces vegetative cover. As a result, activities within/and around streamside unstable areas, especially Class I watercourses, pose an extreme threat to water quality. Newly-constructed road crossings and roads within watercourse and lake protection zones (WLPZs) or equipment limitation zones (ELZs) can also pose an extremely high threat to water quality (Figure 3). Existing road crossings, roads that are close to watercourses, and legacy roads (i.e., older roads not built to today's road construction standards) also have a high potential for delivering sediment once they are subjected to traffic, and should be the focus of monitoring efforts.

The risk to water quality is lower for skidding activities than for roads, with the exception of tractor crossings and skidding within the WLPZ or ELZs. Canopy removal on stable hillslopes has relatively little direct impact on erosion/sedimentation with exception of harvesting trees on or near the bank of watercourses. However, canopy removal within the WLPZ has the potential to affect stream temperature.

The most important points to consider when determining threat to water quality are:

Activities in Unstable Areas

The threat to water quality increases if activities such as road building and timber harvest are proposed within unstable areas with the potential to impact water quality. Risk is highest if the unstable area is immediately adjacent to a watercourse (Figure 3). To determine if your plan area has activities proposed within unstable areas check the following sections, or the THP map, within the paper copy of the THP:

- Section II.21.a. – Will ground based equipment be used on unstable soils or slide areas?
- Section II.24.b. – Are logging roads proposed in areas of unstable soils or know slide-prone areas?

- Section II.24.i. – Are any landings proposed in areas of unstable soils or known slide prone areas?

If any of these items are checked “yes”, the affected areas should become a high priority for monitoring.

Roads and Landings

Roads and landings are capable of generating large amounts of sediment, and are the dominant manmade sources of erosion in many forested areas. The threat to water quality increases if roads and landings are constructed within WLPZs or ELZs, are close to the watercourse, or on steep slopes (i.e., >50-65%) that lead without flattening to a watercourse. To determine if your plan area has roads or landings proposed for construction/reconstruction within any sensitive areas check the following sections within the paper copy of the THP:

- Section II.24.d. – Are roads to be constructed or reconstructed, other than crossings, within the WLPZ of a watercourse?
- Section II.24.e. – Will roads be located across more than 100 feet of lineal distance on slopes over 65%, or on slopes over 50% which are within 100 feet of the boundary of a WLPZ?
- Section II.24.j. – Will landings be located on slopes over 65% or on slopes over 50% which are within 100 feet of the boundary of a WLPZ?

If any of these items are checked “yes”, these features should become a high priority for monitoring.

Tractor Operations

Tractor operations can impact water quality if they occur close to watercourses and/or on steep slopes. Water quality impacts can even occur from areas near ridgetops if waterbreaks are not properly installed, as runoff from long stretches of skid trails can gully and create a cascading effect that can deliver sediment to the watercourse. To determine if your plan area has tractor operations with a higher risk to water quality check the following sections within the paper copy of the THP:

- Section II.21.b. – Will ground based equipment be used on slopes over 65%?
- Section II.21.c. – Will ground based equipment be used on slope over 50% with high or extreme EHR?
- Section II.21.d. – Will new tractor roads be constructed on slopes between 50-65% with moderate EHR?
- Section II.21.e. – Will ground based equipment be used on slopes over 50% which lead without flattening to sufficiently dissipate water flow and trap sediment before it reaches a watercourse or lake?

If any of these items are checked “yes”, these features should become a moderate to high priority for monitoring.

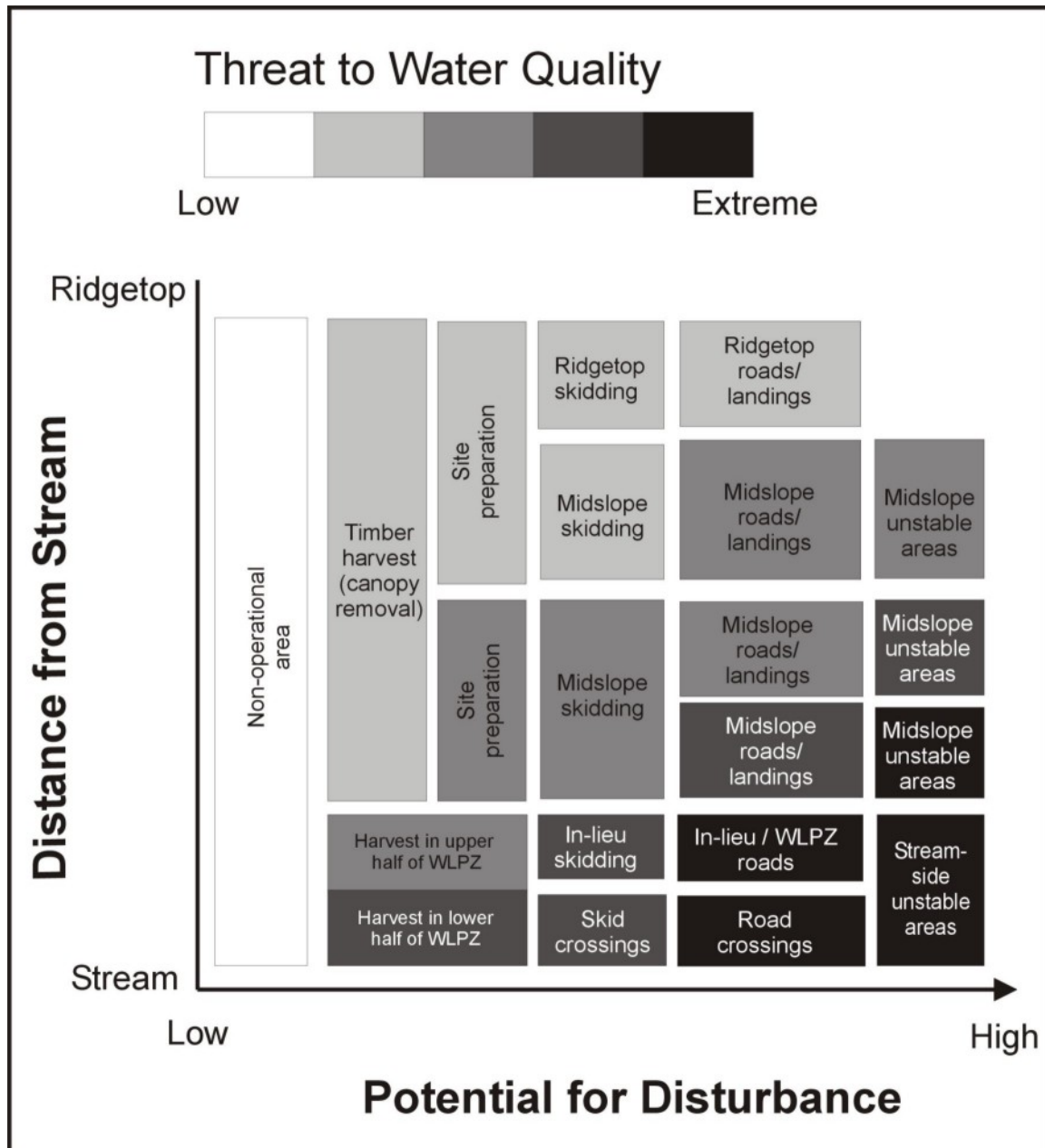


Figure 3. Schematic showing THP activities' threat to water quality as a function of disturbance intensity and distance from watercourse. WLPZ refers to the watercourse and lake protection zone. In-lieu refers to activities that occur within a WLPZ.

Winter Operations

Unless properly mitigated, activities during the winter period (November 15th to April 1st) can make the most benign activities a threat to water quality. If winter operations are a component of the THP, then the scope of monitoring should not be limited to the activities that cause the most disturbance (e.g., roads; operations in unstable areas) or to activities close to watercourses. Winter operations may force you to broaden the scope of monitoring to midslope and upslope areas as well.

3.0. Determining Significant Pollution from Timber Harvest Activities

Forensic and effectiveness monitoring requires that landowners assess whether timber harvest activities have caused significant pollution to waters of the state. Significant pollution typically refers to the impairment of beneficial uses by sediment (i.e., suspended sediment; turbidity; settleable material). An assessment of whether significant pollution has occurred is best done at the hillslope scale. The hillslope scale refers to portions of the THP area that are not within a watercourse or its floodplain. (Figure 4). Significant pollution can also be identified instream at the watershed scale. The watershed scale refers to any portion of the plan that is within the channel or its floodplain (Figure 4).

3.1. Determining Significant Pollution at the Hillslope Scale

For significant pollution to occur at the hillslope scale several factors must be considered. First, there must be an active source of erosion on the hillslope. Second, a significant amount of the sediment must be delivered, or have the potential to be delivered, to a watercourse.

Significant Erosion + Delivery to a Watercourse = Significant Pollution

A significant discharge of sediment varies by watershed, but for the purposes of the monitoring we recommend that the landowner take note of any **noticeable** hillslope sediment discharge to a watercourse that is greater than 1 cubic yard in volume. One cubic yard of sediment is equivalent to a pickup load. A noticeable hillslope sediment discharge is one where the volume can be easily estimated, and may include erosion voids, gullies, or large rills. A sediment discharge of 10 or more cubic yards triggers additional monitoring requirements, including photo-point monitoring and violation reporting. To identify significant pollution, landowners must become familiar with erosion processes and field indicators of sediment production and transport (i.e., erosion features).

Rainsplash erosion is when rainfall falls on the ground and loosens or detaches soil particles from the soil surface (Figure 5). Energy from rainsplash can cause individual soil particles to travel sideways up to 5 feet (Brooks et al., 1991). For example, the energy released during a large rainstorm can detach up to 65 cubic yards of sediment, or a half an inch of soil, on a single acre (i.e., the size of a football field) of bare, loose soil (Brooks et al., 1991)¹. Soils that have lots of vegetative cover resist rainsplash erosion and have low erosion rates. Rainsplash erosion can be a significant source of sediment at road crossings and tractor crossings, due to their proximity to watercourses. It is difficult to determine if significant pollution has occurred from rainsplash erosion. However, rainsplash erosion on bare areas greater than 25 ft by 25 ft have the potential to mobilize more than one cubic yard of sediment. A bare area greater than 85 ft by 85 ft can mobilize more than 10 cubic yards of sediment.

¹ Assuming the soil has a bulk density of 1.6 g cm⁻³.

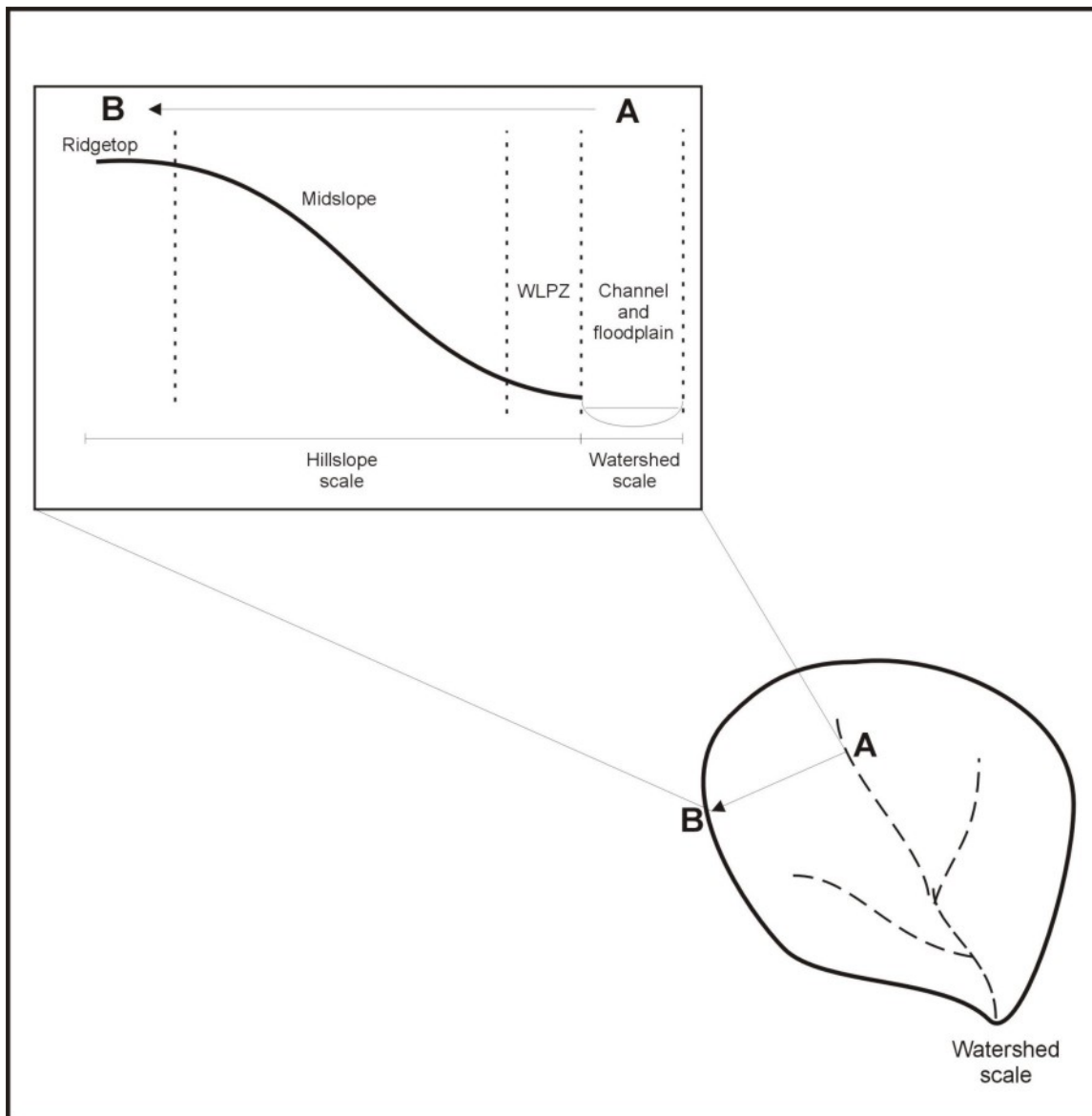


Figure 4. Schematic illustrating the various scales of monitoring. At the hillslope scale the threat to water quality is highest near the channel and decreases as you move to the ridgetop. Watershed scale monitoring is done in the channel and monitoring is difficult because conditions in the channel represent everything upstream or uphill from the point of monitoring.

Sheetwash erosion occurs when the intensity of rainfall is greater than the capacity of the soil to infiltrate the water. As a result, water accumulates on the soil surface and runs downhill as an irregular sheet of runoff. The depth and velocity of runoff increases as it progresses downhill and eventually the energy becomes sufficient to erode soil (Figure 5). An important point to consider is that erosion increases with deeper runoff and steeper slopes:

Erosion \approx Runoff Depth x Slope

Sheetwash is common on compacted surfaces such as roads and skid trails, and on soils with little or no vegetative cover. Roads and skid trails with a heavy layer of dust are especially susceptible to sheetwash erosion. Sheetwash erosion removes a nearly uniform depth of soil and can be hard to distinguish in the field. One thing to look for is pedestaling: a condition where soil is eroded around rocks or plants, leaving them on small pedestals of soil. A quick estimate of sediment volume can be determined by multiplying the depth of erosion (i.e., height of pedestaling) by the area affected by sheetwash erosion.

When sheetwash cuts small channels into the ground it is called **rill erosion** or rilling. These small channels are 2 to 12 inches wide, and up to 12 inches deep (Knighton, 1998). Rilling is the dominant form of sediment transport on bare soil, resulting in 50 to 90% of total erosion (Knighton, 1998). A quick estimate of sediment volume can be determined by multiplying the rill length by the average rill width and average rill length (i.e. average depth x average width x length).

Gully erosion occurs when rills exceed 12 inches in depth and 12 inches wide (Knighton, 1998). Gullies typically have a headcut at the upslope end, which progresses uphill until it reaches a resistant structure such as downed wood or rock. Gullies can also form in association with landsliding or the collapse of soil macropores². A quick estimate of sediment volume can be determined by multiplying the gully length by the average gully width and average gully depth (i.e. average depth x average width x length).

Mass movement refers to a gravity-driven, downhill movement of soil, rock, and debris. Mass movement occurs when the forces that drive instability (i.e., gravity; weight of soil/rock) exceed the forces that promote stability (i.e., the ability of the soil to hold together; friction that resists landslide movement along the failure plane). Mass movement is commonly referred to as landsliding, but also consists of soil creep, debris slides, slumps, earth flows, debris flows, etc. Mass movement from timber harvest activities are typically associated with roads (Sidle et al., 1984). However, canopy removal in unstable areas, and poorly drained skid trails and cable roads near unstable areas can also increase the likelihood of mass movement.

² Large interconnected voids under the soil surface that carry runoff during storm events.

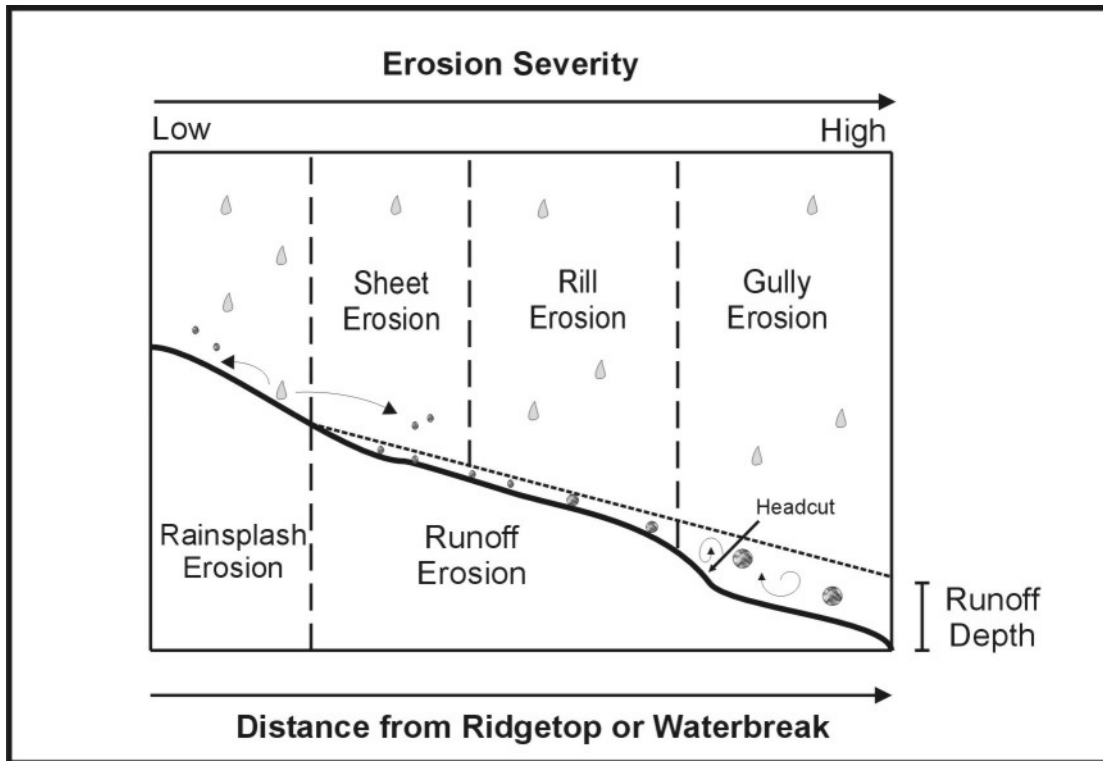


Figure 5. Stages and severity of surface erosion as a function of distance from ridgetop or waterbreak.

Once it has occurred, mass movement is relatively easy to identify in the field. Look for landslide scars on the hillslope (Figure 6), or large sediment deposits near the watercourse. A landslide scar is the bare surface left by the movement of rock or unconsolidated soil. Sediment volume can be rapidly estimated by multiplying the area of the landslide scar by the depth of the scar.

3.2. Determining Significant Pollution at the Watershed Scale

Determining significant pollution at the watershed scale requires visual monitoring of instream conditions. It is difficult to evaluate significant pollution via instream monitoring because the condition of the stream may be a result of natural erosion, manmade erosion, or both. Visual instream monitoring can be a useful tool for determining the location of significant sources of hillslope erosion. This can be done by observing the clarity of water at different locations (i.e., upstream or downstream) in the THP area. Visual monitoring of water clarity (i.e., turbidity) is especially useful at road-stream crossings because you can look at water quality above and below the crossing to determine if significant pollution is occurring.



Figure 6. Looking down at a landslide scar.

Other indicators of significant pollution at the watershed scale include gravel embeddedness, pool sedimentation, stream channel aggradation, stream channel degradation (i.e., downcutting; channel incision), and bank erosion.

Gravel embeddedness is the degree to which fine sediment (i.e., sand sized and smaller) surrounds gravels and cobble on the surface of the stream (Figure 7). Embeddedness becomes higher as gravel and cobbles become more and more buried by fine sediment.

Pool sedimentation is the presence of fine sediment in pools. Pool sedimentation indicates high rates of fine sediment delivery to a stream channel (Figure 8). It is recognized as sand sized (i.e., less than $1/12^{\text{th}}$ an inch in diameter), or smaller, particles that deposit in a channel pool. Fine sediment in pools is typically more indicative of watershed wide sediment production rather than pollution from individual timber management activities.

Stream channel aggradation is when the elevation of the stream channel rises in response to excess sediment. It is indicative of high rates of coarse sediment delivery (i.e., $1/12^{\text{th}}$ an inch in diameter or greater) to a stream channel. Channel aggradation is typically associated with large inputs of sediment from landslides or failed road-stream crossings. Channel aggradation typically causes a widening of the stream and overbank flooding.

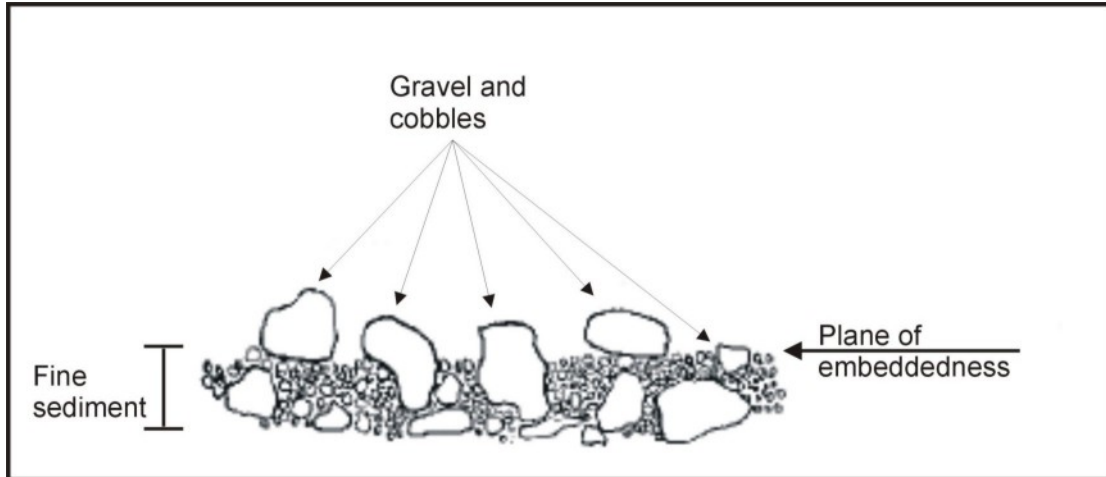
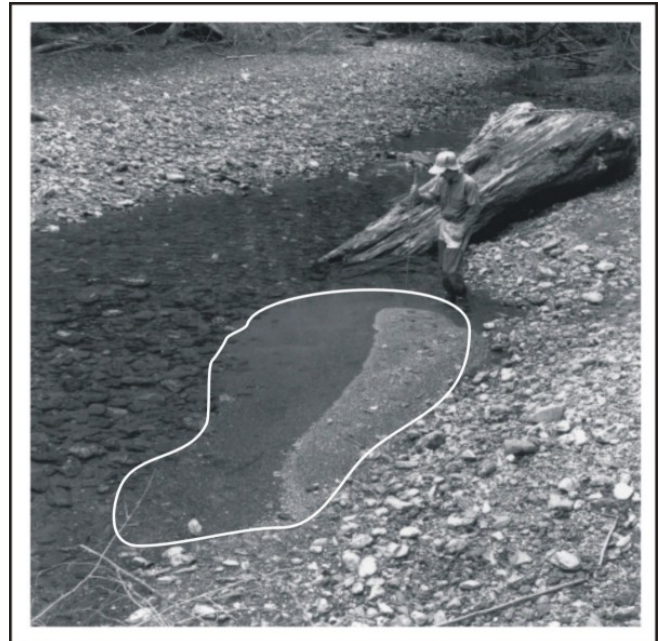


Figure 7. A schematic illustrating gravel/cobble embeddedness. Embeddedness increases as the plane of embeddedness covers most of the gravel/cobbles (from Bunte and Abt, 2001).

Stream channel degradation (i.e., stream downcutting) can result from landsliding or peak flow events. Scour from landsliding (i.e., debris flows) can cause downcutting if the receiving channel is steep enough. Downcutting can also occur in response to large peak flows or the local modification of channel hydraulics. Stream downcutting is common when road runoff is drained into small channels (i.e., Class III channels). The process of channel downcutting may produce significant pollution.

Figure 8. Fine sediment deposition in the pools of a watercourse indicates a high supply of sediment from upstream sources (Lisle and Hilton, 1999³).



³ Reproduced/modified by permission of American Geophysical Union.

Bank erosion may occur when trees are harvested on the banks of channels. There is speculation that bank erosion can increase due to timber harvest-induced increases in peak flows. However, it is generally difficult to visually link the hydrologic effects of timber harvest to increased bank erosion.